

Tornado History

Indiana's tornado history extends back to its early settlement. There are records of tornadoes occurring in Indiana as far back as 1814, but there are few statistics on these early twisters. The worst outbreak of tornadoes in the state's history, in terms of fatalities, occurred on Palm Sunday, April 11, 1965. There were at least 10 tornadoes and a number of lesser storms reported on that date. The official death toll for Indiana from this storm was 137. These Tornadoes also struck Illinois, Ohio, and Michigan. As the tornadoes moved across north central Indiana, they destroyed the Town of Russiaville, and caused extensive damage in Kokomo, Lebanon, and Marion. A total of 32 counties suffered damage; 18 of those counties experienced major damage. Seventy-one million dollars in private property damage and \$13.5 million in public property damage resulted from these storms.

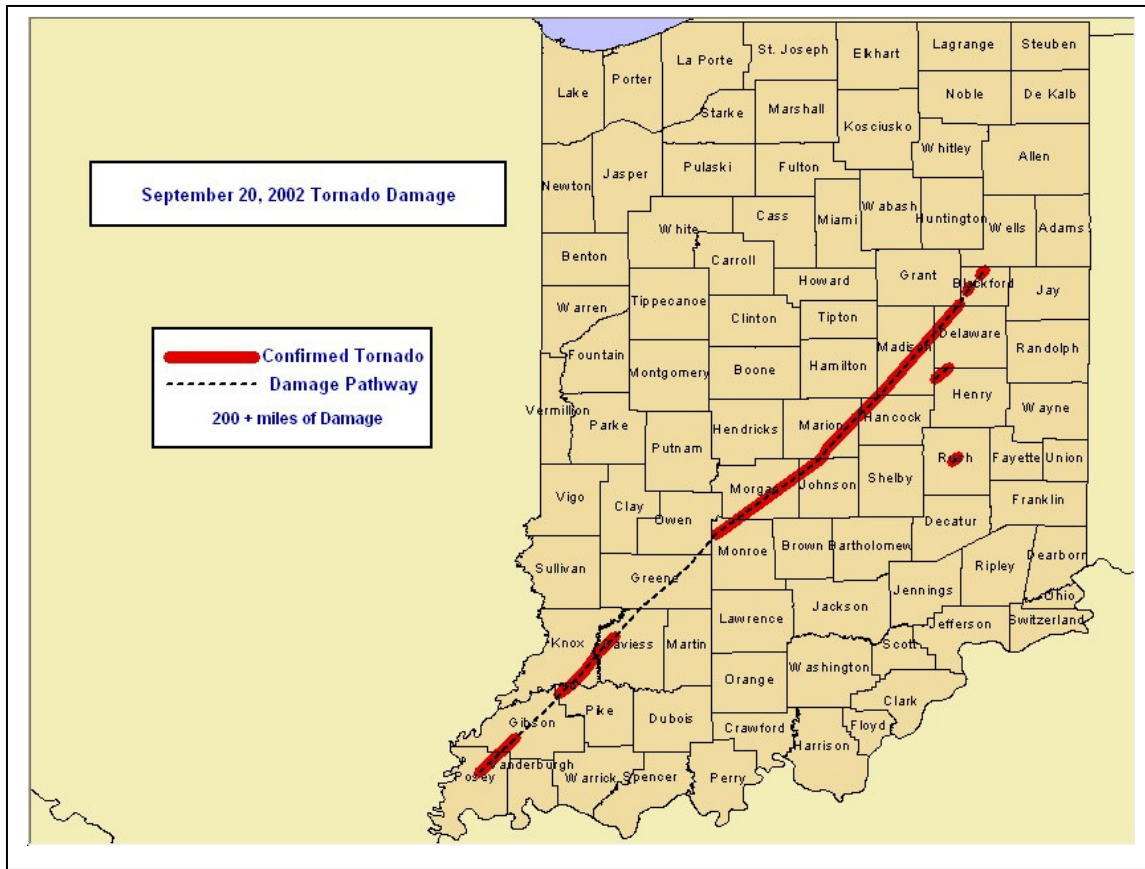


June 2003 Miami County Tornado Damage

The second most deadly tornado day of record was on March 18, 1925, when 74 people were killed in southwest Indiana. Fifty deaths occurred in the City of Griffin in Posey County. The tornado all but destroyed the town. This Tornado set records for speed, path length and deaths per city. In Indiana, multiple funnels were occasionally visible, as the 3/4-mile-wide path of destruction continued with no letup. The town of Griffin lost 150 homes, and children were killed on their way home from school. Two deaths were in a bus. Another stretch of rural devastation occurred between Griffin and Princeton, passing just northwest of Owensville. About 85 farms were devastated in that area. About half of Princeton was destroyed, and losses there totaled \$1,800,000. The funnel dissipated about 10 miles northeast of Princeton.

On April 3, 1974, a Super Cell struck the Midwest and southern U.S. This series of storms produced 148 tornadoes across 13 states. Twenty-one tornadoes touched down in Indiana causing damage in 39 counties. The death toll in the state was 47 with nearly a thousand people hospitalized with storm-related injuries. Total losses to property, utilities and infrastructure approached \$100 million. The downtown business district in Monticello in White County was almost completely destroyed. This was the largest tornado outbreak ever in the United States.

On June 2, 1990, the largest outbreak of tornadoes hit Indiana; 37 tornadoes ripped across 31 counties, killing 8 people. Downtown Petersburg was severely damaged. Across the Midwest, this outbreak produced 64 tornadoes in 9 states, and killed 9 people.



On September 20, 2002, Indiana was again struck by a series of severe storms, which resulted in a Presidentially declared Tornado disaster for 32 of the counties. One of the tornadoes generated in this event struck Indianapolis and caused the second longest track in Indiana's history. This event represents the most concentrated outbreak of such weather in Indiana over the past 30 years. These storms produced tornadoes that caused extensive damage to homes, businesses, and public facilities throughout a significant portion of the State, doing over \$9,118,918.00 in damage.

March, April and May are the most severe tornado months. Tornadoes can occur at any hour of the day or night, but because of the meteorological combinations that create them, they form most readily during the warmer hours of the day. Most tornadoes occur between 3-9 p.m. The direction from which tornadoes strike has been reported in about 75% of the cases. Indications are that 80% of these tornadoes come from the West or Southwest. An historical survey of tornado accounts indicates that a tornado can occur in almost any section of the state and at any elevation, from hilltop to valley bottom. The greatest number of tornadoes have been observed and reported in central and northern Indiana.

INDIANA TORNADO RECORDS

Most tornadoes in a day - 37 on June 2, 1990
Most tornadoes in a month - 44 in June, 1990
Most tornadoes in a year - 49 in 1990
Most tornado deaths in a single event - 137 on April 11, 1965

INDIANA'S WORST TORNADOES

April 13, 1852 New Harmony - 16 dead
May 14, 1886 Anderson - 43 dead
March 23, 1913 Terre Haute - 21 dead
March 23, 1917 New Castle - 21 dead
March 28, 1920 Allen through Wayne counties - 39 people killed by 3 tornadoes
April 17, 1922 Warren through Delaware counties - 14 dead
March 18, 1925 Tri-State tornado - 70 dead
March 26, 1948 Vigo to Jay counties - 20 dead
May 11, 1949 Sullivan and Clay counties - Coatsville destroyed, 14 dead
April 11, 1965 Palm Sunday Outbreak - 11 tornadoes hit 20 counties, 137 dead
April 3, 1974 Super Outbreak - 21 tornadoes hit 39 counties, 47 dead
March 10, 1986 8 tornadoes hit central and southern 9 counties, 1 dead, 48 injured
June 2, 1990 31 counties hit by 37 tornadoes, 8 dead, 220 injured

*** Please refer to the maps in the back of the plan for a detailed representation of past tornado locations, tracks, and intensity.*

Tornado Vulnerability

Based on reported damages from tornadoes, the following summaries explain what is vulnerable to such storms. This information provides helpful information in determining current and future damage exposure.

- Urbanized and industrial areas face the greatest vulnerability because of their concentration of buildings, population and lifeline utilities. Because of the nature of tornadoes, the exposure to loss increases as the population density increases.
- Electrical, water, and gas utilities are vulnerable because of direct or indirect impact caused as a result of the loss of power to water facilities, downed trees, debris, destroyed buildings, etc.

- Economic impact from loss of crops, livestock, storage facilities and light industry can have permanent or long-lasting impact on communities in many Indiana counties. Because the economy of some rural counties is less diversified, a single tornado may destroy the economic livelihood of a majority of the county's population.

Current Exposure

Population Exposure - Due to the random patterns of tornadoes and the historical touchdown patterns in Indiana, the entire geographic area and population can be considered at risk. Although central and northern Indiana have been struck most frequently, all of the state's population is at potential risk. Tornado records in Indiana date back to 1814. On an annual basis since 1953 the State has averaged 1-3 tornadoes in the southern third of the state and 7-9 tornadoes in the central/north central area of the state. The statewide average during this time has been 21 tornadoes per year. The number of fatalities per annum numbered seven.

INDIANA TORNADO RANKINGS			
NUMBER	FATALITIES	INJURIES	ADJUSTED \$\$
(15) 886	(6) 218	(6) 3641	(2) \$164,865,433.00

The numbers in () reflect the National ranking of these categories from 1950-1995.

Human Services Exposure - Human service agencies (community support programs, health and medical services, public assistance programs and social services) often suffer the effects of a tornado. The two main effects are a loss of personnel and damage or destruction to local infrastructure. This damage consists of physical damage to facilities and equipment, disruption of emergency communications, loss of health and medical facilities and supplies and an overwhelming load of patients and clients who are suffering from the effects of the tornado.

Transportation Exposure - The current network of interstates, federal, state and county roads, and city streets should provide access to any area of Indiana in the event of tornadoes. It is anticipated that transportation blockage by damage and debris will be localized and temporary. Rail shipments should not be interrupted for any significant time even by major tornadoes. Air traffic can be re-routed to other airfields in the event of damage to a specific air terminal.

Other Infrastructure Exposure - Other infrastructure consists of public utilities, such as water, electric, gas and telephone. Loss of water can result from the lack

of electric power to operate the equipment or from the damage and destruction of aboveground components of the supply network. Loss of the gas supply network should follow the pattern of the water system. Loss of electricity and telephone networks can result from the damage or destruction of aboveground components of the system. Loss of power can also result in the loss of water and sewage treatment capabilities.

Economic Exposure - The negative economic consequences from tornado damage can consist of destruction and damage to business and personal assets, lost wages due to temporary or permanent closure of businesses, diminution of tax base due to destroyed assets, recovery costs, and lost investments in destroyed property.

Future Exposure

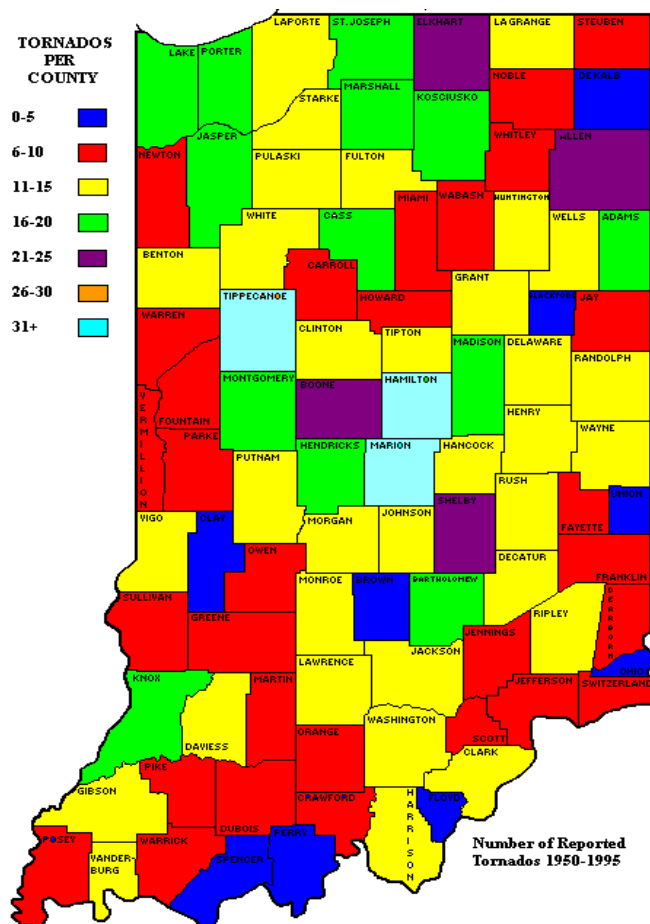
Due to the fact that tornadoes strike at random and since Indiana is located in "Tornado Alley," all of Indiana is considered exposed to tornadoes. Recent construction of new buildings to codes that address tornado strength winds will reduce damage in future events. Continuing efforts to increase public awareness to the dangers of tornadoes should mitigate injury, death and property losses in the future. As the population increases and more areas are developed, the potential damage from such storms will increase.

Loss Estimation

Loss Potential

The loss potential from tornadoes cannot be accurately predicted given the tornado history of the state there is significant potential for injuries and loss of life, damage to the economic structure and damage to the infrastructure.

Each tornado is an isolated column of wind. However each tornado can be part of larger systems known as Super Cells. These cells produce swarms of tornadoes over large geographic areas.



Indiana has suffered major damage and loss of life from three of these Super Cells that covered large areas of the state.

Potential within Indiana's "Tornado Alley" for widespread economic and personal loss.

The loss potential from tornadoes is due to buildings being toppled, mobile homes being overturned, trees being uprooted, people, vehicles, and animals being hurled through the air and the air being filled with wind borne debris. A 1989 publication from the U.S. Department of Commerce (National Weather Service) stated that between 1953 and 1980, Indiana annually averaged three deaths from eight tornadoes. Between 1950 and 1994 Indiana recorded 886 tornadoes that produced 1,025 touch downs and generated \$1.6 billion in property damage.

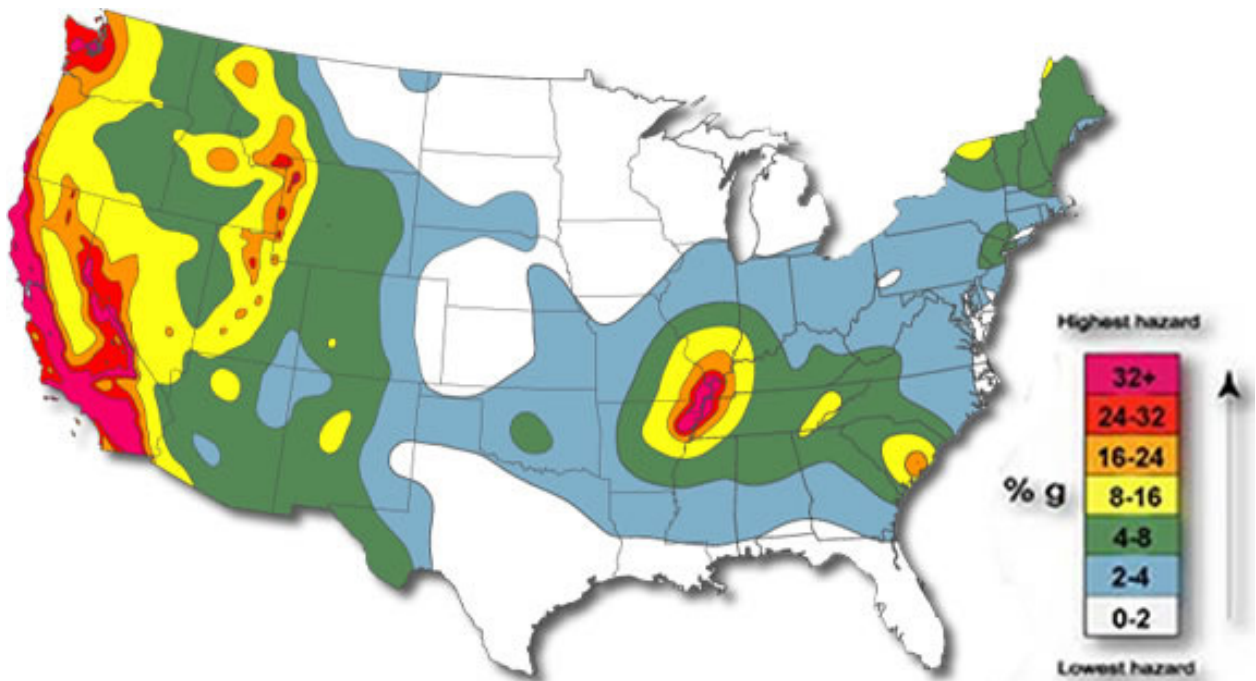
Failure to pursue a program of tornado preparedness and mitigation will result in increased loss of lives and property. Federal, state and local government information-education programs have saved many lives in the past. Many communities have incorporated tornado resistant standards into local building codes. Education programs in public schools teach children at an early age to be aware of the dangers of tornadoes and what action to take when one occurs. Special public awareness and information programs, such as Tornado Awareness Week sponsored by National Weather Service and the Indiana Emergency Management Community emphasize proper actions during a tornado. Without these kinds of programs and the continuing emphasis on tornado preparedness, the losses in lives and property can be expected to increase.

Enhanced F Scale for Tornado Damage

An update to the original F-scale by a team of meteorologists and wind engineers that was implemented in the U.S. on 1 February 2007.

FUJITA SCALE			DERIVED EF SCALE		OPERATIONAL EF SCALE	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

United States Earthquake Hazard Map



Earthquake History

Indiana's prehistoric features and recorded history indicate the state has been and will continue to be seismically active. Although most of the recent earthquakes in Indiana's history have been minor to moderate, there have been large earthquakes striking a history of Indiana. One of the largest earthquakes recorded in Indiana was a magnitude 5.2 or greater earthquake that struck near Sullivan, Indiana. With the evidence of large pre-historic earthquakes in and very near Indiana's borders, in the future it is very likely a large catastrophic earthquake will again strike Indiana.

The **New Madrid Seismic Zone** extends from Northwest Arkansas to the Southwest corner of Indiana. In the winter of 1811-1812, this region was struck by a series of the largest earthquakes recorded in the continental United States. The largest of the shocks exceeded an estimated magnitude 8.0, with over 2,500 after shocks. The force released by these earthquakes caused the Mississippi River to change course and flow backwards and church bells were rung in Boston, Massachusetts. Over 200 small earthquakes are reported in this region every year.

The **Wabash Valley Seismic Zone** extends up the Indiana/Illinois border from Western Kentucky. In recent history, the Wabash Valley Seismic Zone has produced

a series of moderate earthquakes. In 1909, 1968, 1987, and 2002 this area has produced moderate size earthquakes in the range of magnitude 5.0.



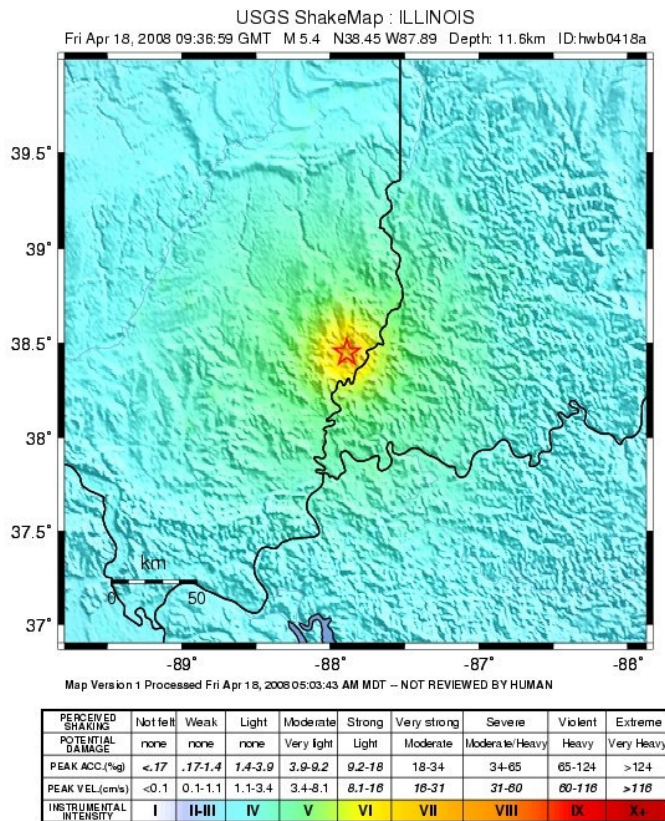
Recently evidence of large earthquakes in the range of magnitude 7.0-7.5 that have occurred in the last 6000 years has been found on the Wabash and White Rivers near the Indiana/Illinois border. With this the cities of Evansville, Vincennes, Terre Haute, Indianapolis and the other smaller cities and towns within this region are drawn closer to seismically active areas.

The **Western Ohio Seismic Zone** located in Shelby and Auglaize Counties in Western Ohio have a history of producing moderate damaging earthquakes. Geologists believe that this seismic zone can cause larger earthquakes that can cause extensive damage in the region. Indiana Cities such as Ft. Wayne and Richmond lie nearly 50 miles from the Western Ohio Seismic Zone.

Earthquakes in the Central or Eastern United States affect much larger areas than similar earthquakes on the West Coast of the United States. For example, the Great San Francisco Earthquake of 1906 (Magnitude 7.8) was felt in 15,000 square miles around the epicenter. By contrast, the Great New Madrid Earthquake in 1811 was felt in over 2,000,000 square miles, where church bells in Boston were reported being rung. The Geology in the Central United State sits on loose unconsolidated soils that permit the further transmission of the earthquake's energy.

Differences in geology east and west of the Rocky Mountains cause this strong contrast. Indiana and the Midwest have not been traditionally been considered to be an active seismic area. However, given the states soil composition, the types of earthquake faults (intra plate faults) and the older less quake resistant structures (building and infrastructure) the damage would be likely be greater than that seen in

the traditional earthquake area of Southern California for a similar magnitude earthquake. The areas most vulnerable do not change.



It is interesting to note that as IDHS was finalizing this plan the Wabash Valley Seismic Zone experienced a 5.2 earthquake. Its epicenter was near West Salem, Illinois. The earthquake was felt in Chicago, Louisville, Indianapolis and Fort Wayne. As indicated earlier in this plan, this seismic area is capable of much stronger events. This event was significant enough to generate an interest in earthquake risk to the population in the State of Indiana and the region.

Damage, as the chart at the bottom of this figure indicates, will likely come from unreinforced masonry structures which are extremely susceptible to earthquake tremors. This is true for older brick construction buildings. In fact, a historic structure in New Harmony suffered damage as did one in downtown Louisville, Kentucky. Other susceptible items are non-flex gas connectors, unsecured propane tanks, water heaters, tall bookcases, etc which have been the bulk of the damages reported during this most recent event. IDHS will make full use of this event to highlight the existing risk in Indiana to earthquakes.